

Multi-eared Listening: Pathways to Equitable Partnerships for a Transdisciplinary Ecoacoustics

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Multi-Eared Listening is a call to integrate Indigenous, local, and Western scientific knowledges in a transdisciplinary ecoacoustic research. Following the Mi'kmaw principle of *Two-Eyed Seeing*, *Multi-Eared Listening*, points to the importance of braiding epistemologies in ecoacoustic research and conservation. Case studies from Ecuador, Ghana, Indonesia, Australia, and transnational sound art initiatives demonstrate how collaborative, community-led projects can bridge ecological and cultural dimensions of environmental sound for ecological and cultural conservation. These examples reveal soundscapes as both ecological indicators and vital expressions of cultural identity, reciprocity, and territorial belonging. We argue that developing equitable partnerships in ecoacoustics is not only an ethical imperative but also essential for producing more inclusive, effective conservation outcomes. By fostering mutual respect, shared authorship, and epistemological parity, *Multi-Eared Listening* proposes a new paradigm for ecoacoustics—one that aligns biodiversity monitoring with biocultural justice, strengthens Indigenous sovereignty, and reimagines conservation as a relational, restorative, and plural act of listening.

Introduction

The Kunming-Montreal Global Biodiversity Framework (GBF) (CBD 2022) recognizes the crucial role of indigenous peoples and local communities (IPLCs) in conservation that necessitates their full and effective participation in decision-making. Central to this is recognition of roles of Indigenous Peoples and Local Communities in biodiversity conservation and the establishment of principles for equitable governance that respect their knowledge and rights. Indigenous Peoples account for just over six percent of the global population but are custodians of more than a third of the world's most

important areas for biodiversity (IUCN, 2021). However, as recently pointed out in a Policy Matters editorial (Dawson et al 2023), beyond indigenous autonomous territories, only a small minority of conservation initiatives across the globe currently adhere to GBF standards. Adhering to principles of equitable governance and respect of rights and knowledge requires a widespread shift in mainstream conservation practice – one that is both morally imperative and holds the greatest potential to address biodiversity loss and promote socially just outcomes. Given this gulf between policy and practice, conservation efforts globally are at a critical juncture. There are many possible trajectories between “the global expansion of inequitable, externally-led forms of conservation at one end, and at the other, a shift towards the recognition of Indigenous peoples’ and local communities’ knowledge systems and empowerment of their custodianship of nature.” (Dawson et al, 2024 p.2). What we do next as ecoacoustic researchers matters.

The GBF has triggered billions of dollars of investment in conserving, restoring, and sustainably managing ecosystems. Ecoacoustics, and Passive Acoustic Monitoring (PAM) in particular, has huge potential to support these global conservation efforts. However, whilst the development and application of ecoacoustic technologies for conservation are accelerating, many ecological, technical, and ethical questions remain (Alcocer 2022, Gibb 2024, Longdon 2020). As Chapman et al (2024) remind us, unless we centre issues of environmental and data justice in conservation research including PAM, there is a real danger that future conservation technologies, data collection, and decision-making will reproduce and further entrench past inequities. However, ethical frameworks for Ecoacoustics are worryingly underdeveloped. In the first report on the state of conservation technology Speaker et al., (2022), 250 surveys and focus groups with 45 leading practitioners rated the primary concerns of the community. Only 10% of the community considered “ethics” to be in the top three challenges facing the field.

At a critical time in the decline of biodiversity, the proliferation of conservation technologies, and the continued abuse of the rights of Indigenous peoples, we highlight the need to develop *transdisciplinary* and *equitable* partnerships in Ecoacoustics, including the explicit interweaving of traditional and technoscientific ways of listening. We propose that by developing transdisciplinary ecoacoustics in an equitable way, there are opportunities to braid Western knowledges with Indigenous and traditional knowledges and ways of knowing *together with* emerging technologies toward more positive ecological, social and cultural outcomes for biodiversity, Indigenous and local peoples, and wider planetary health. We call this *Multi-Eared Listening*.

The term *Multi-Eared Listening* follows the *Two-Eyed Seeing* concept, advanced by Canadian Indigenous leaders, notably Mi'kmaw Elders Albert and Murdena Marshall and the Centre for Integrative Science in Canada (Bartlett et al., 2012). Two-Eyed Seeing, *Etuaptmu'k* in the Mi'kmaw language is defined as “learning to see from one eye with the strengths of Indigenous knowledges and ways of knowing, and from the other eye with the strengths of mainstream knowledges and ways of knowing, and to use both these eyes together, for the benefit of all” (Bartlett et al., 2012, p335). Originally introduced in an educational context, Two-Eyed Seeing has an explicit action imperative: central to is the notion that *knowledge transforms the holder* and that the holder bears a responsibility to act on that knowledge. Two-Eyed Seeing has been integrated in research, policy, and strategic plans across Canada. More recently it has inspired a framework to guide ethical development and application of AI (Bourgeois-Doyle, 2019). Multi-Eared Listening similarly advocates learning to *hear* through one ear with the strengths of Indigenous knowledges and ways of knowing and from another ear with the strengths of mainstream knowledges and ways of knowing. We conjure a mythical Multi-Eared being to acknowledge the intrinsic plurality of listening (Drever and Hugill, 2022). With these other ears we learn to hear with and attend to the plethora of emerging opportunities

and potential issues associated with evolving forms of machine listening that subserve computational ecoacoustics (e.g. Kahl et al. 2021, Nieto Mora et al., 2025, Gibb et al. 2024), and the myriad sound-based knowledges practiced across the world.

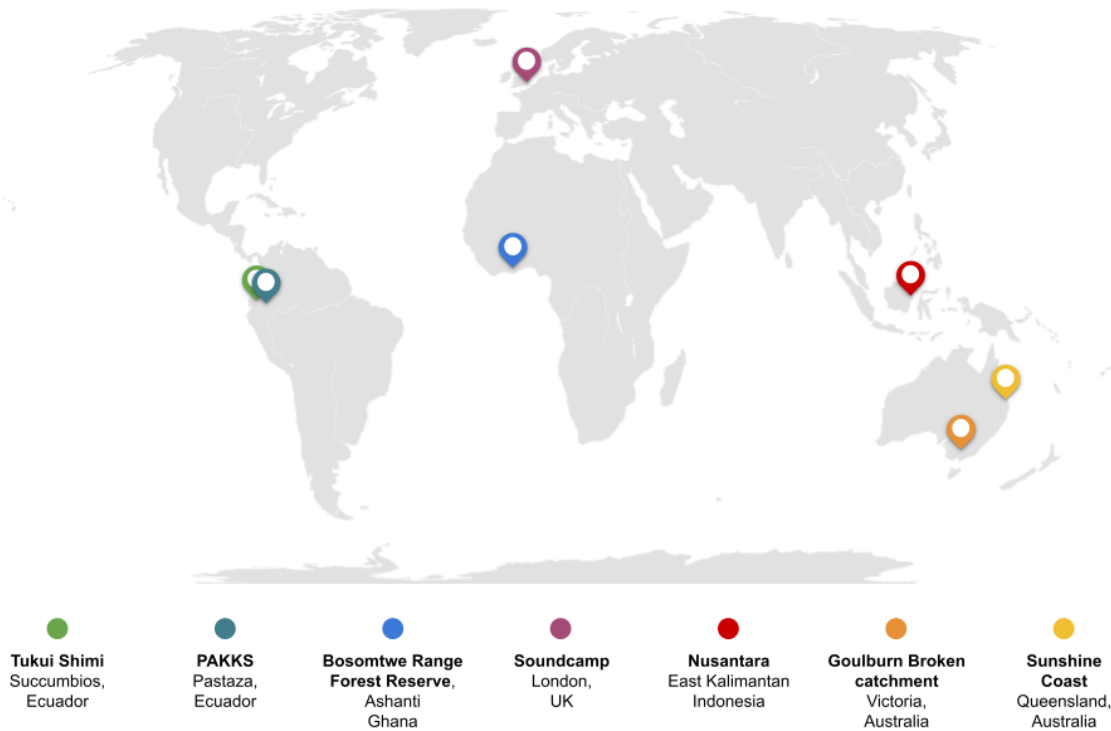


Figure 1. Locations of case studies indicating association, community, or area, province and country. Base map credit: Equal earth projection blank map from wikimedia.

To introduce and illustrate the possibilities of Multi-Eared Listening, we share case-studies from our existing projects across art, science, and applied ecoacoustics that have been carried out collaboratively by holders of traditional knowledge, traditional custodians of land, and communities across Africa, Southeast Asia, South America and Australia. European, North American and Australian researchers, arts practitioners and conservation actors, (see Figure 1 for locations). Applied case studies are accompanied by Indigenous and European perspectives on the importance of braiding Indigenous and local knowledges equitably. This conversation is both an ethical imperative and a rich opportunity to share ideas, practices and methods; it points to the importance of sustained collaborations and equitable partnerships in developing long term approaches to biodiversity conservation and environmental justice.

Case studies

Territory: Indigenous Peoples and the Conservation of Biodiversity

Mónica Chuji Gualing and, *Tukui Shimi*¹

For Indigenous Peoples it is fundamental to share that, according to our cosmovisions or ways of being, human beings are part of the immense biodiversity of the planet; we have a deep connection and interaction with all beings in Nature and with the energies in the diverse ecosystems that exist in our territories. We conceive of life in its totality first, and only then do we particularise it. This totality of life translates into a diversity of lives existing in Nature, and from each of those lives emanate sounds that are integral to our existence. Sound is one of the myriad ways in which life expresses itself. Each tree, each lake, each waterfall has its own sound, its own murmur that reaches our ears and enters our spirit and consciousness, allowing us to feel, know and assimilate these beings that are connected and interdependent with the rest of our territories and the complex ecosystems they comprise. Nature is our mother and our teacher.

The care and conservation of Mother Earth and all its biodiversity requires that Indigenous systems of knowledge and mainstream arts and sciences be included in intercultural dialogue. We must formally and legally recognise Indigenous Peoples' territories, knowledge, and autonomy, because territory *is* life with dignity. Western science and Indigenous science must be jointly embraced in order to shift the hearts and minds of dominant society and politics, and inspire change in real world practices to heal our planet and ensure a sustainable future.

Participatory ecoacoustic monitoring of social-ecological change with Indigenous and local community partners surrounding Indonesia's new capital city

Wendy M. Erb, Walker DePuy, Shorna Allred, Rustam

Soundscapes are a potent yet under-utilized avenue for understanding and monitoring human-environment relationships (Moscoso et al 2018). Sounds collected using autonomous recording units (ARUs) can be analyzed to monitor wildlife, inventory biodiversity, and assess ecosystem health. At the same time, soundscapes hold cultural meaning, represent environmental knowledge, and shape community identities and practices (DePuy et al. 2025). While ARUs can provide snapshots of sound events, the embodied sensory knowledge of people can enrich and challenge understandings of sound- and landscapes. Our work with customary knowledge-holders in two front-line communities examines the impacts of Indonesia's new capital city, Nusantara, on its human and non-human residents. Weaving together data from passive acoustic monitoring (9 ARU recording sites) and community ethnography (12 soundwalks, 4 listening sessions, and 16 interviews), we are documenting how sense of place is captured, produced, and understood through sound and what stands to be altered, created, or lost by Nusantara's development. We demonstrate the value of soundscapes in understanding impacts across the human-ecological continuum and illustrate some of the challenges and opportunities of implementing inclusive, sound-based research praxes that braid multiple ways of knowing (DePuy et al. 2025). Our work seeks to demonstrate how such a

¹ <https://tukuishimi.org/> (all the voices) is a non-profit women-led Indigenous organization based in Ecuador that supports Indigenous communities in protecting their territories, biodiversity, and safeguarding their ancestral knowledge.

transdisciplinary action research model can lead to improved understandings of and outcomes for the connections among people, nature, and place.

Narrating the Forest: The Cultural Centrality of Storytelling in Participatory Bioacoustics with Forest Fringe Communities in Ghana

Joycelyn Longdon

Participatory methods in the field of ecoacoustics are not uncommon, with the engagement of citizen scientists in data collecting and labelling roles often playing a crucial role. Yet, like many other approaches to conservation, there is uneven community engagement across the North-South divide. Whilst there is increased enthusiasm and support for participatory ecoacoustics with Indigenous peoples and Local Communities, there is a lack of documented methods of participation that directly challenge coloniality and uneven power dynamics in, or engage with community-led approaches to, the participatory process.

Through our participatory ecoacoustics project with a forest fringe community in Ghana (Longdon 2023), we identify the recurring emergence of narrative and storytelling as a community-led approach to data analysis and sensemaking. We find that resisting colonial, Western-centric modes of engagement and prioritising the cultural centrality of storytelling in West African culture leads to richer, more engaged and grounded participatory ecoacoustics engagements.

Using Ecoacoustics and other monitoring techniques to work with Traditional Owners to bring Biocultural perspectives to environmental water discussions

Jo Geddes

The Goulburn Broken catchment is an area of 2,391,544 hectares or 10.5% of the total land area in Victoria, New South Wales, Australia. It includes the catchments of the Goulburn and Broken Rivers and is home to approximately 3,600 wetlands. Of these wetlands, only ten can receive environmental water allocations, which is water set aside by the Government for specific use in rivers and wetlands for their protection. The two main Traditional Owner groups within these catchments are Yorta Yorta and Taungurung. The Goulburn Broken Catchment Management Authority (CMA) works closely with these two groups to align cultural and environmental values when delivering environmental water to these sites. Monitoring techniques such as Ecoacoustics are being used by the CMA to inform decision making for watering these sites. These monitoring results are being shared with Taungurung Land and Water Council to support Taungurung Traditional Owners in bringing biocultural perspectives to environmental watering discussions.

Listening with Ecosystems: Transdisciplinary Approaches to Ecoacoustics

Leah Barclay

Research at the Sunshine Coast brings together specialists in sound art, digital technology, acoustic engineering, and environmental sciences to work directly with communities to develop and deploy

acoustic sensors and map ecological changes. Every stage of the research process — from methodology design to fieldwork — is an equal balance between artistic and scientific perspectives. The interdisciplinary impact and outcomes of projects exploring the changing soundscapes of ecosystems over the last decade illustrate the value of this approach. *Listening to Country* (Woodland et al 2019) explores the value of ecoacoustics in promoting cultural connection and wellbeing among Aboriginal and Torres Strait Islander women in prison; *Biosphere Soundscapes* (Barclay 2014) maps the ecoacoustics of UNESCO Biosphere Reserves; and *River Listening* (Barclay et al 2020) has pioneered the field of freshwater ecoacoustics by demonstrating that sound is a key measure of ecosystem health and presents new opportunities for freshwater conservation. These initiatives highlight the application of ecoacoustics from varied ecological and cultural perspectives. Addressing the current technological, ethical, and methodological challenges faced in advancing ecoacoustic research highlights the necessity of foregrounding ethical practices in community-engaged ecoacoustics projects. By fostering an equitable balance between artistic and scientific processes, this transdisciplinary approach not only enhances ecological monitoring but also strengthens the cultural value of ecoacoustics and the importance of decolonising approaches in collaborative transdisciplinary research.

Sacha Taki - Registering the Songs and Voices of the Forest as intangible cultural heritage in Ecuador for the Ancestral Kichwa Peoples of the Living Forest

Pueblo Ancestral Kichwa Kawsak Sacha, Paola Moscoso and Alice Eldridge.

The Pueblo Ancestral Kichwa Kawsak Sacha (Ancestral Kichwa Peoples of the Living Forest, PAKKS) are six Kichwa communities in the Ecuadorian Amazon. These communities are: Macao, Sisa, Lorocachi, Jatun Playa, and Victoria, located in the lower basin of the Kuraray River, and Yana Yaku in the lower basin of the Pinduk Yaku River. In total, PAKKS comprises 103 families and 700 inhabitants. In 2008, the PAKKS were recognized by the Ecuadorian State, with a territory of 199,456 hectares.

Since 1992, the PAKKS have been developing the *Sumak Kawsay Plan* – toward the autonomous administration and control of territory based on three principles: *Sumak Allpa* – Conserved Territory, *Sacha Runa Yachay* – Ancestral Wisdom, and *Sumak Kawsay* – Life in Harmony. One of the four principal projects in the Sumak Kawsay plan is the *Sacha Taki* proposal.

Sacha Taki means “Songs and Voices of the Forest” (Sacha means forest, and Taki means songs, or voices and refers to humans, forest animals as well as spirits or guardians of the forest). Sacha Taki is a proposal for the conservation of biological diversity and the strengthening of cultural diversity through the recognition of the importance of biocultural sound heritage, which connects both and reflects their state of health. The PAKKS recognise that biocultural diversity is expressed through soundscapes as a nexus that links what Western discourses have conventionally designated ‘nature’ and ‘culture’. It is understood that it is impossible to understand or protect one without considering the other.

The songs of the hummingbird, the river, the spirit guardians of sacred places such as the salt lick, the tapir, the stones, and the voices of women singing as they sow cassava are understood as vital expressions sustaining both community and territorial life. Through a participatory action research project in 2021, some of these biocultural meanings and values of the songs and voices of the forest were surfaced and articulated in the form of illustrations and a film. Sacha Taki have subsequently

been successfully registered as national intangible cultural heritage in Ecuador. We understand that this is the first national intangible cultural heritage recognition of forest sounds.

The central assumption of computational ecoacoustics in Western science – that the soundscape reflects the ecological status of a given biome – is shared by the Sacha Taki proposal: for the PAKKS “a living forest is a singing forest.” Sacha Taki as biocultural manifestations reflect the ecological health of the territory, but also the foundation of cultural continuity and a central principle of social and ecological organization. More than an indicator of ecological health, Sacha Taki are manifestations of a complex biocultural web which supports the co-continuity of human inhabitants and wider forest ecosystem - the living territory.

Reveil – Live Ecoacoustics

Grant Smith

The Soundcamp Cooperative come to ecoacoustics from work with live environmental sound and transmission, especially the annual Reveil broadcast (2014–ongoing), which invites practitioners to send in live audio streams as first light reaches their locations on Dawn Chorus Day (Scarfe 2023). Streams are hosted by Locus Sonus in Aix-Marseille, mixed by artists in London, Santiago, Sunshine Coast and Crete, and relayed on Wave Farm (US), Resonance Extra (UK) and a consortium of FM and net radios around the world. Thirty simultaneous soundcamps give ways to connect with particular places, while several thousand listeners can meet and chat at soundtent.org/reveil, exchanging thoughts and information about the streams. Reveil can be thought of as a long-form transmission work co-created between human and non-human communities, agencies, matters and collectives. It is also an annual gathering of the Acoustic Commons network, which provides creative/technical resources: thinking and DIY infrastructures which allow live sounds to travel beyond earshot, extending listening to less heard sites and situations (Baraitser Smith 2025). This involves a wide understanding of the acoustic and the ecological, that folds environmental, social and personal together [Guattari]. Thinking through and with these tools and approaches with others is a way to open questions about listening and transmission as *relational* practice, and the patterns, flows and problematics they give rise to.

Summary and Future

Ecoacoustics to date has focused primarily on the *ecological* meanings of sounds and their application in biodiversity monitoring from a Western scientific perspective. As well as a paucity of ecological theory (Farina et al., 2021), there is an alarming absence of ethical frameworks to guide this work. The scale of current global conservation initiatives means that we can no longer continue without addressing the ethical impact of our work (Chapman et al., 2024). The case studies shared here bring together Indigenous leaders and arts practitioners, ecoacoustics researchers, ecologists, customary landowners, and other conservation actors in different ways to explore the importance and value of braiding Western, traditional and Indigenous knowledges and ways of knowing with ecoacoustic methods and technologies.

These case studies begin to illustrate what we might learn through Multi-Eared Listening. For example, the Sacha Taki project highlights that as well as ecological indicators, forest sounds are rich

carriers of meaning culturally, socially and spiritually, and play a vital role as biocultural interfaces between humans and the wider ecosystems which sustain communities. This recognition is already integrated into the management of environmental water in Goulburn Broken catchment where government ecologists support Taungurung Traditional Owners in bringing biocultural perspectives to environmental watering discussions. In addition to the foundational ethical imperative, we suggest that multi-eared listening is a rich opportunity to enhance our understandings of the socio-ecological role of natural soundscapes. As a starting point we consider three intersecting dimensions of the importance of developing Multi-Eared listening, each with associated open questions.

Ethical importance of Multi-Eared Listening

Our ethical frameworks, the methods we use and the tools we build influence each other and the outcomes for conservation as well as ecosocial justice. Whilst operating in a wide range of ecological contexts across continents, our shared conviction is that we not only have a moral imperative to repair ecosocial injustice arising from past imbalances, but it's a critical time to avoid rapidly advancing conservation technology manifesting a new imperialism. If we develop transdisciplinary ecoacoustics in an equitable way, there are rich opportunities for sharing and braiding ecological knowledges toward positive ecological, social and cultural outcomes. Chapman et al. (2024) and others suggest that interdisciplinary collaboration and inclusive, bottom-up processes will be critical for leveraging past, present, and future biodiversity data in a way that aligns with the equity goals of global biodiversity policy.

An urgent future strand of Ecoacoustics research will be to establish ethical frameworks which draw from and develop best practice in related fields including conservation technology, data justice and indigenous research paradigms (e.g. Sandbrook et al., 2021; Thompson, et al 2020; Lovett et al 2019; Walter et al, 2021). Future technologies should be built by drawing from and adapting participatory design strategies, as signalled by Longdon's work with Ghanaian Forest communities. Where relevant, we might consider ways to train local collaborators in acoustic survey methods following the successful paraecology model that has led to upholding of Rights of Nature (Peck et al. 2024). At the very least all researchers operating in indigenous territories must obtain Free, Prior and Informed Consent.

Such considerations are central to the development of truly equitable partnerships – in which there is mutual participation, mutual trust and respect, mutual benefit and equal value placed on each partners' contribution at all stages of research and practice. This is one way to ensure that ecoacoustic methods of recording and data processing contest, rather than reproduce coloniality².

Ecological importance of Multi-Eared Listening

In wider conservation, the eco-social benefits of Indigenous and Local governance are well documented. In a recent meta review of global conservation initiatives (Dawson et al 2024) developed a typology of Indigenous Peoples and Local Community roles in governance and analysed relationships with social and ecological outcomes. The findings reveal that more equitable governance, based on equal partnership or primary control for Indigenous Peoples and Local Communities, are associated with significantly more positive ecological outcomes.

Beyond sharing knowledges and best practices for social and ecological conservation and revitalization, collaborative partnerships in Multi-Eared Listening point to the best possible outcomes for co-development of future ecoacoustic methods and practices. If we build tools *with* communities

² Coloniality here is understood as 'patterns of power that.. define culture, labour, intersubjective relations, and knowledge production.. beyond.. colonial administrations.' (Maldonado-Torres 2007 in Au 2023).

that align with local practices, the potential value to enhance traditional custodianship of those ecosystems is enhanced. A key question for future collaborations will be how we best nurture trust and exchange whilst guarding against extractivist patterns of the past (as seen, for example in the evolution of ethnobotany leading to industrialisation of traditional plant medicines). This is partly about according epistemological parity to Indigenous and Western knowledges and ways of knowing (Latour, 1993. Stein et al, 2024). As the experiences of case study authors here attest, one route to this is through development of the strong friendships that grow from sustained, respectful collaboration.

Cultural importance of Multi-Eared Listening

A multitude of wise researchers, scholars, thinkers and leaders from across disciplines and cultures suggest that underpinning the current biodiversity, climate, social and political crises is a crisis of *relation*. As botanist and Indigenous scholar Robin Wall Kimmerer put it, “It’s not just land that is broken, but more importantly, our relationship to land.” (Kimmerer, 2013). As ecologists in general, and ecoacousticians in particular know, studying and listening to the language of life is a route back to the *subjectification* of other beings. But this knowledge tends to stay visceral and unarticulated. The dominant ideology of extractivism is radically enabled by a belief in human exceptionalism and the objectification of the rest of life. By forging equitable partnerships with communities that centre fundamental reciprocity and recognise the interconnectedness of life, we learn to listen with ears that recognise all other living beings as centres of experience and subjects of rights.

Equitable and transdisciplinary partnerships in Ecoacoustics also provide a means to communicate indigenous perspectives through creative collaborations. The Sacha Taki project fosters biocultural heritage and builds a path toward territorial autonomy for the PAKKS. For Western viewers of the documentary film, it presents a vision of the soundscape as a biocultural web that reflects as well as sustains socioecological co-continuity. The Art-science collaborations in the Sunshine Coast biosphere similarly share creative outputs that reseed ideologies of reciprocity and belonging for non-indigenous audiences.

Conclusion

In its first decade of existence, Ecoacoustics has established itself as a new field of ecological enquiry which is fast delivering on its promise to revolutionise ecological monitoring. In the next decade we need also to foster equitable partnerships in order to address the global biodiversity crisis in ways that foreground rights and justice. By introducing the concept of Multi-Eared Listening we encourage the global Ecoacoustic community to open their ears to other ways of knowing, to learn to listen with the ears of Indigenous knowledges and ways of knowing, Western science and art, and emerging listening technologies. By fostering mutual respect, shared ownership, and epistemological parity, *Multi-Eared Listening* proposes a new paradigm for ecoacoustics — one that aligns environmental monitoring with biocultural justice, strengthens Indigenous sovereignty, and reimagines conservation as relational, restorative, and plural acts of listening.

Contributions

The impulse for this work came through the collaborations of all those mentioned here and more. Alice Eldridge and Leah Barclay proposed and chaired a session of the same name at the 2024 Ecoacoustics Congress, Madrid where Joycelyn Longdon, Jo Geddes, Monica Chuju Gualinga and Wendy Erb presented their case studies. Grant Smith, Leah Barclay, Jo Geddes, Joycelyn Longdon, Monica Chuji Gualinga, Paola Moscoso, PAKKS, Rustam, Shorna Allred, Walker DePuy and Wendy

Erb all wrote their case studies and contributed to the wider framing. All authors reviewed the manuscript.

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